FIG. 1

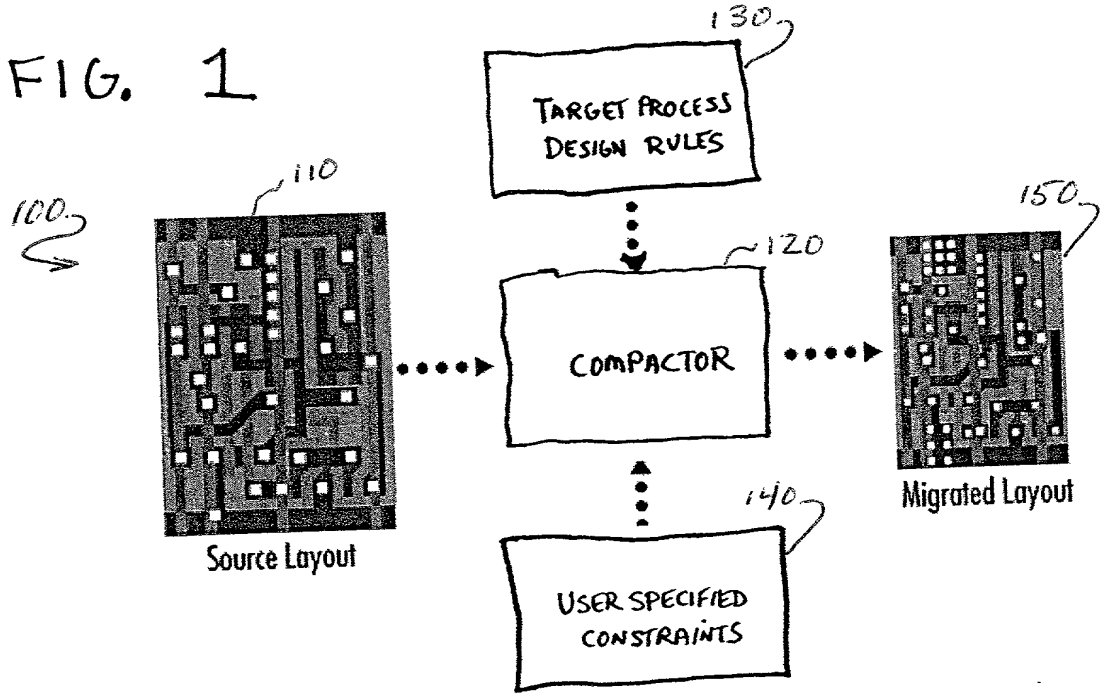

130
TARGET PROCESS DESIGN RULES
110
100
150
120
COMPACTOR
Source Layout
Migrated Layout
140
USER SPECIFIED CONSTRAINTS

FIG. 2

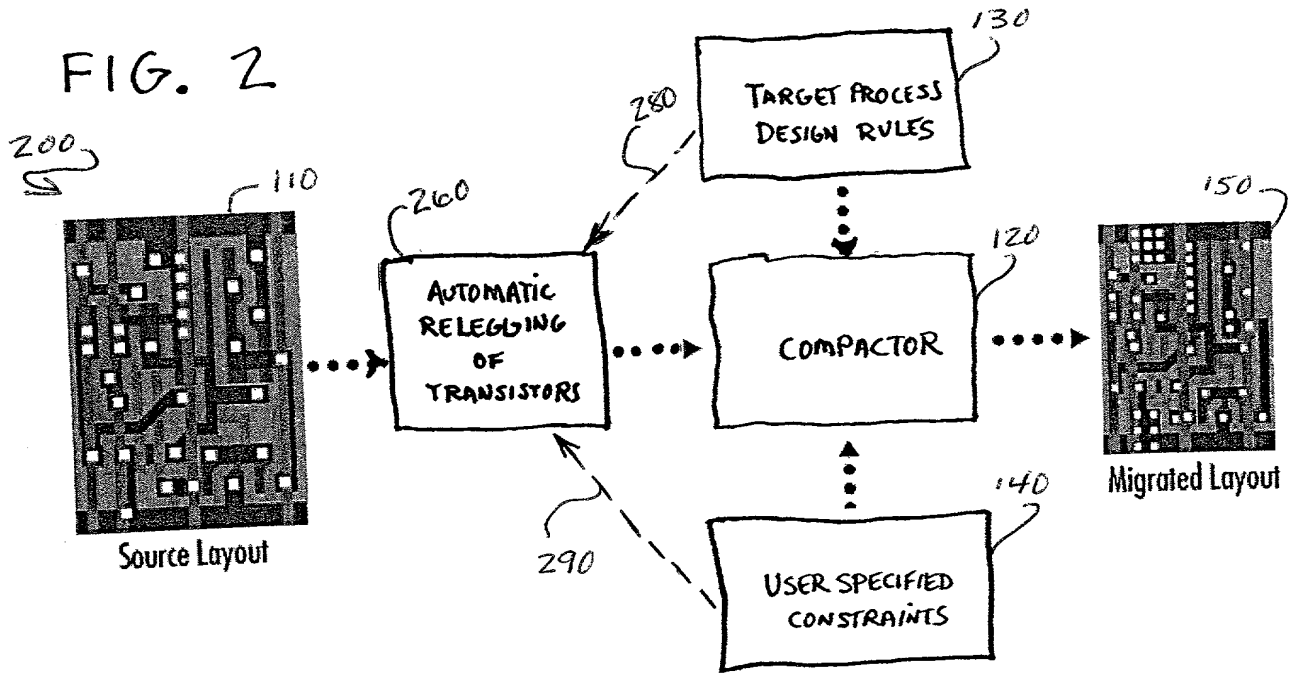

130
TARGET PROCESS DESIGN RULES
280
200
110
260
150
120
AUTOMATIC RELEGGING OF TRANSISTORS
COMPACTOR
Source Layout
Migrated Layout
290
140
USER SPECIFIED CONSTRAINTS

FIG. 3

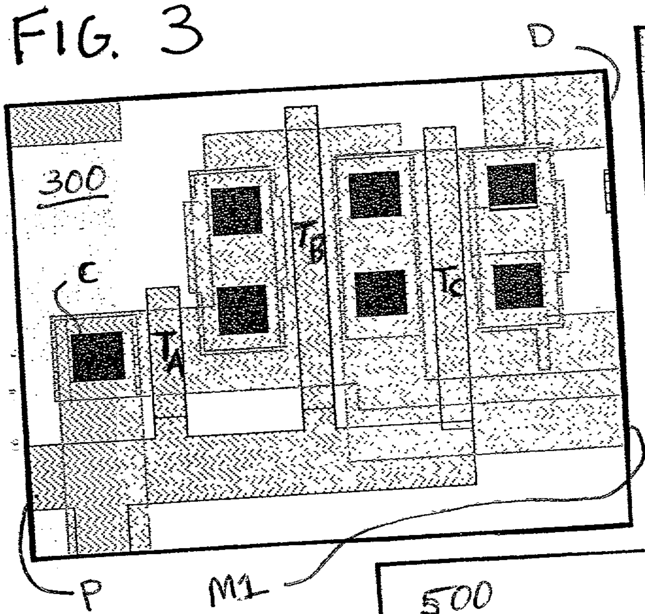


FIG. 4

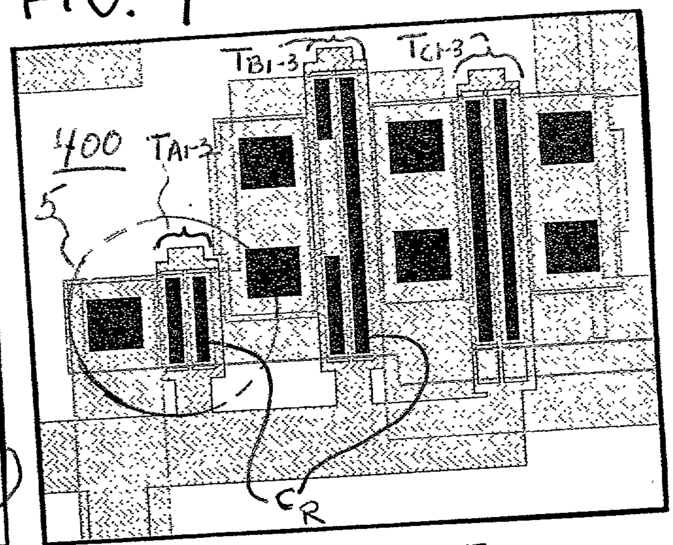


FIG. 5

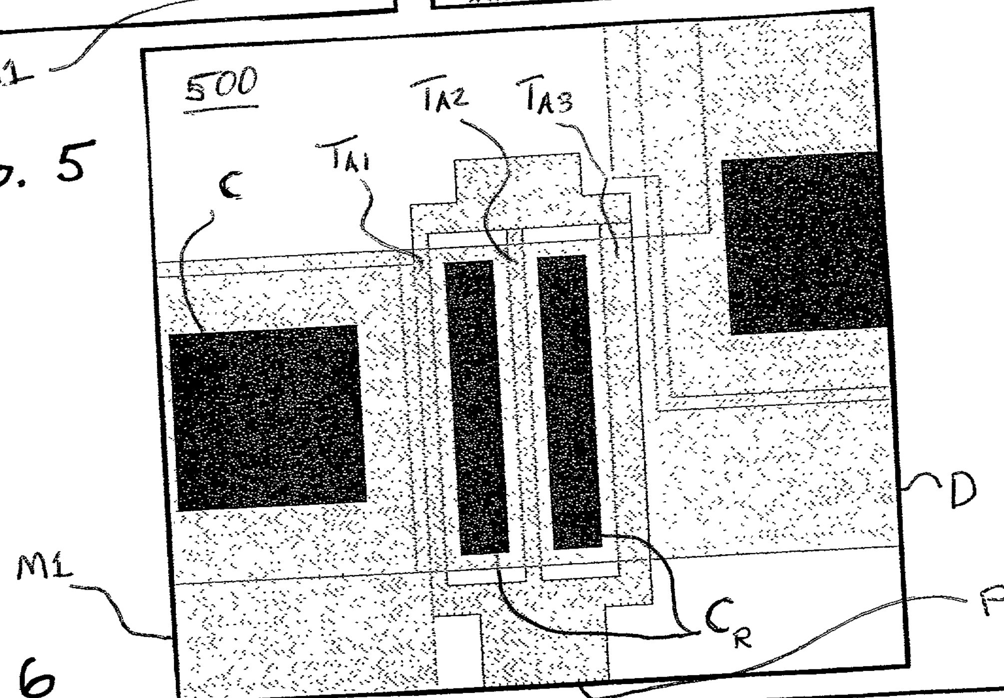


FIG. 6

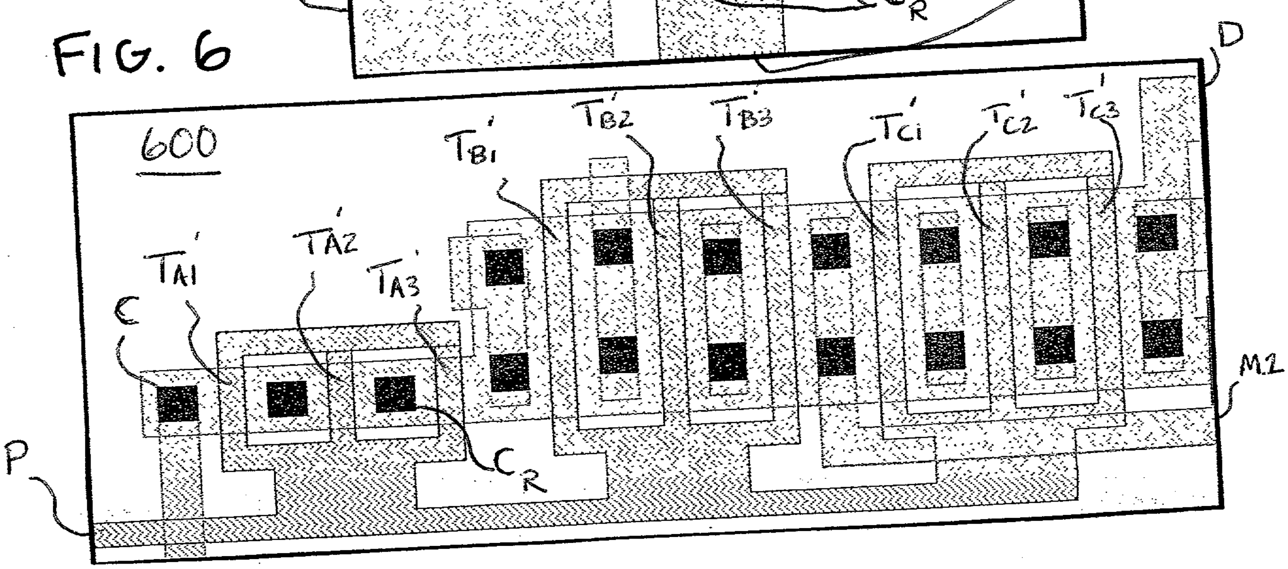


FIG. 7

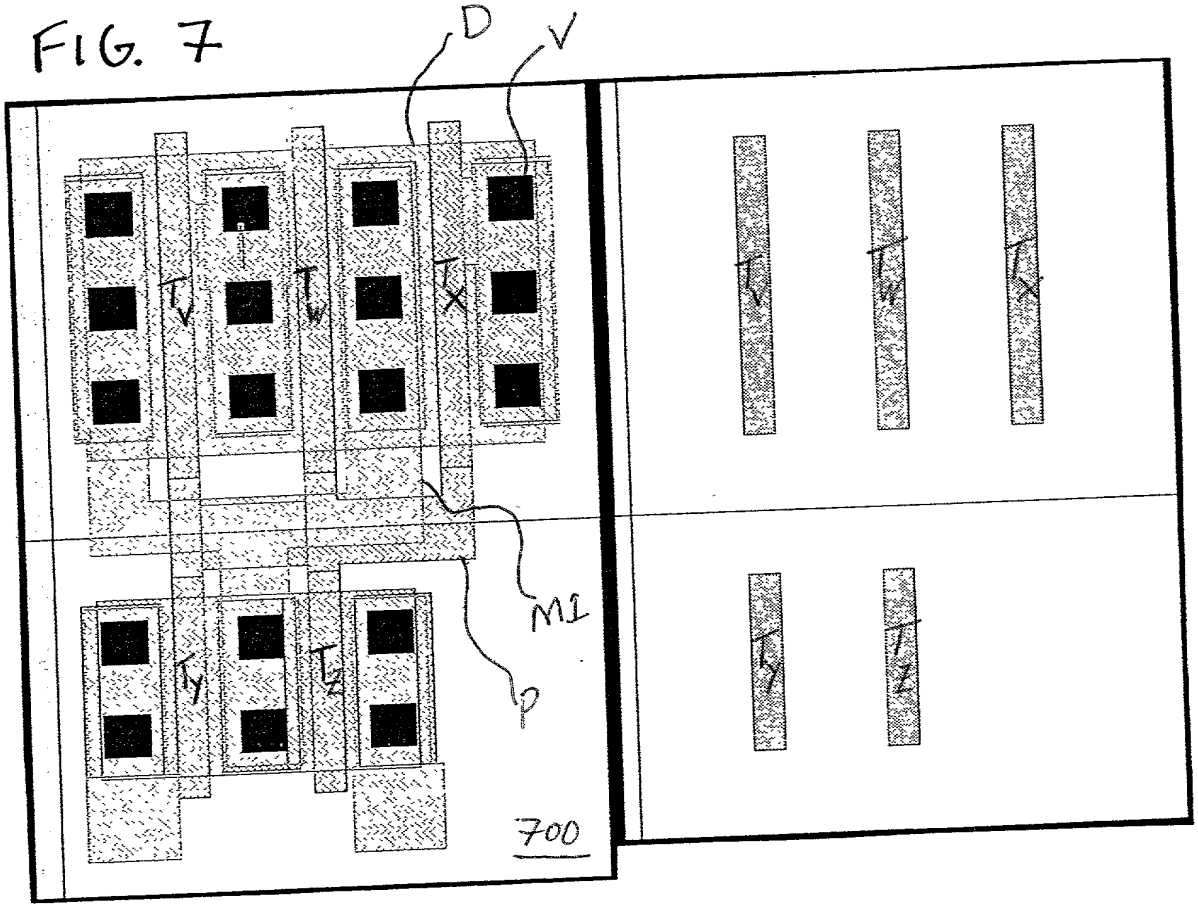


FIG. 8

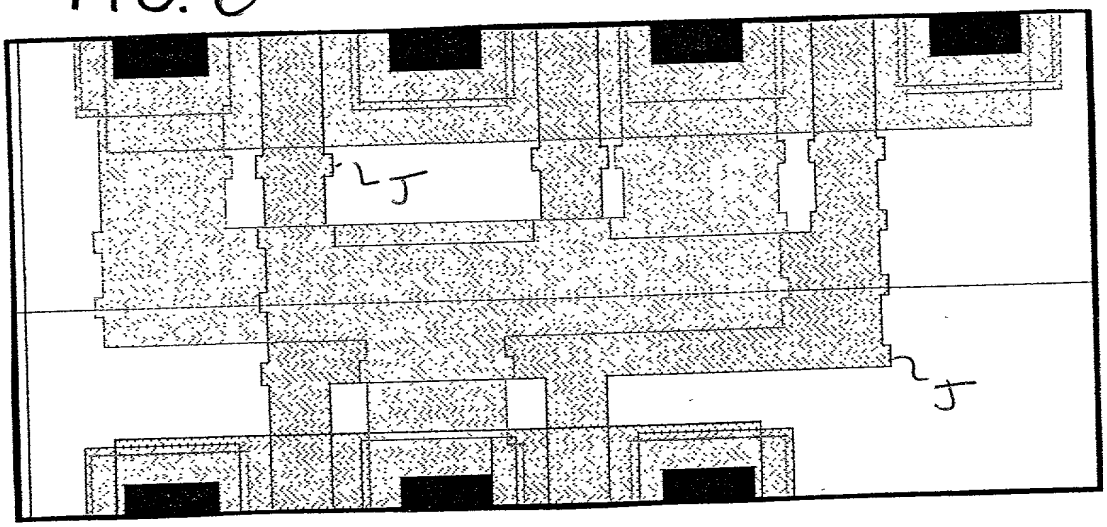


FIG. 9

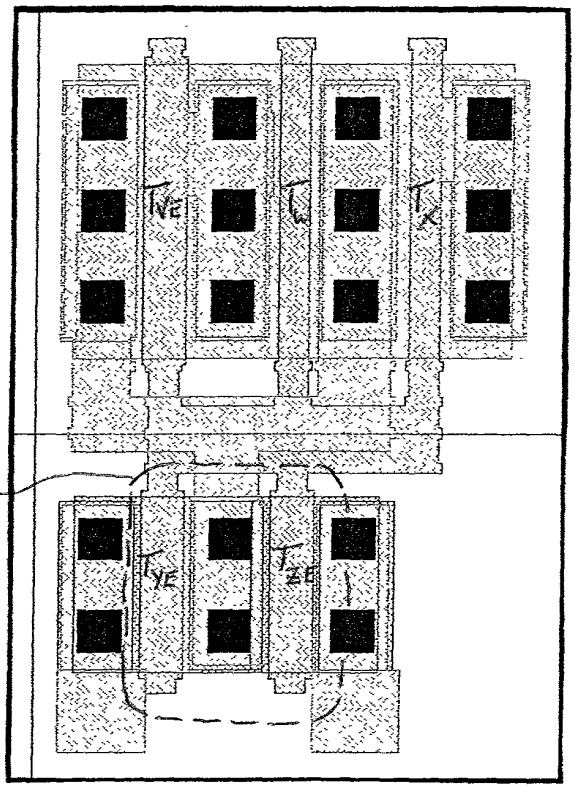


FIG. 10

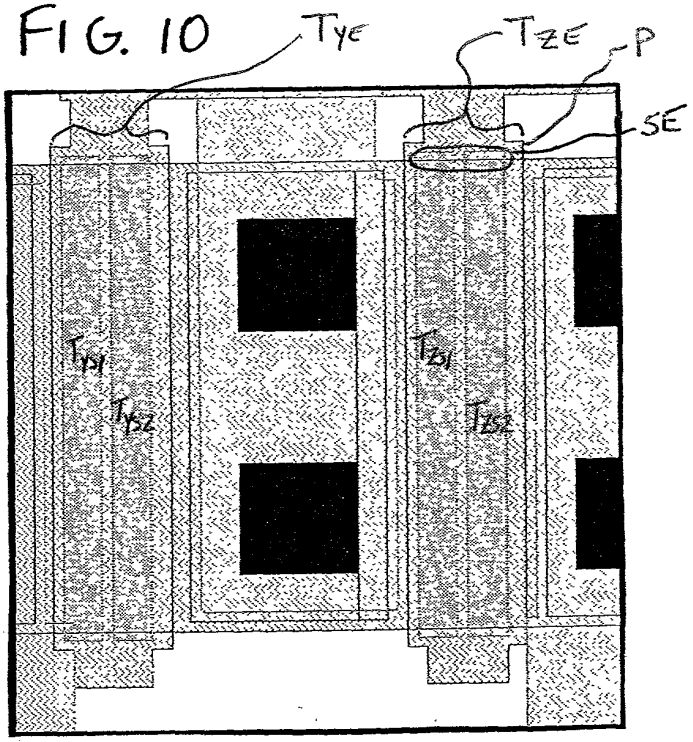


FIG. 11

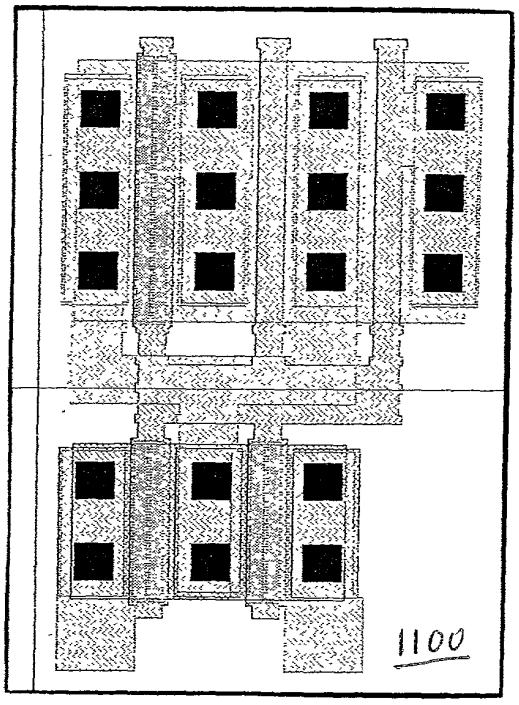


FIG. 12

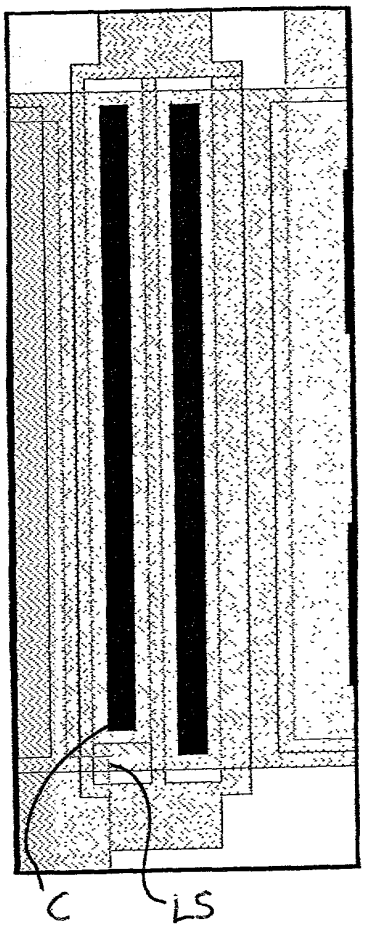


FIG. 13

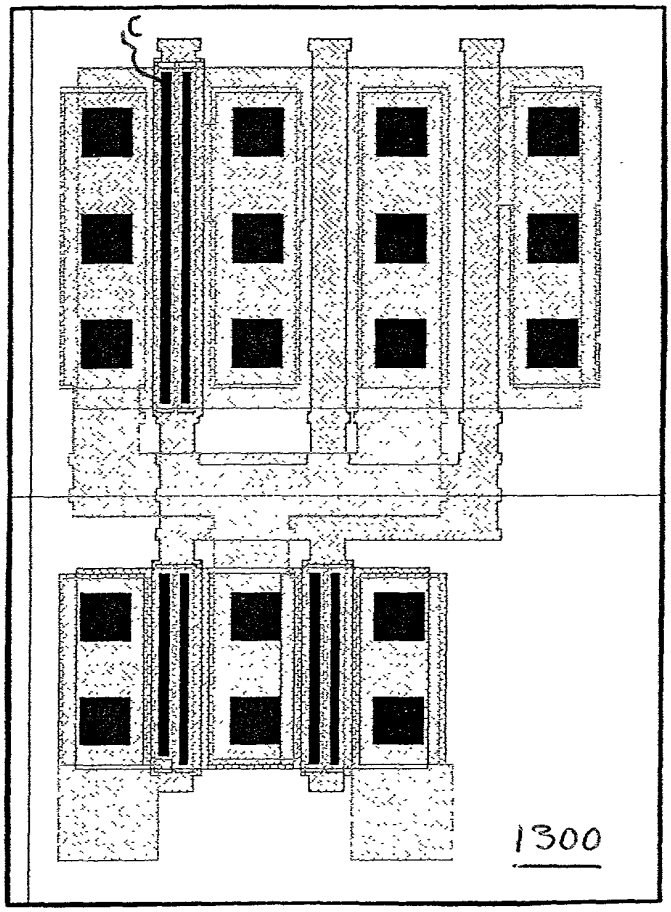


FIG. 14

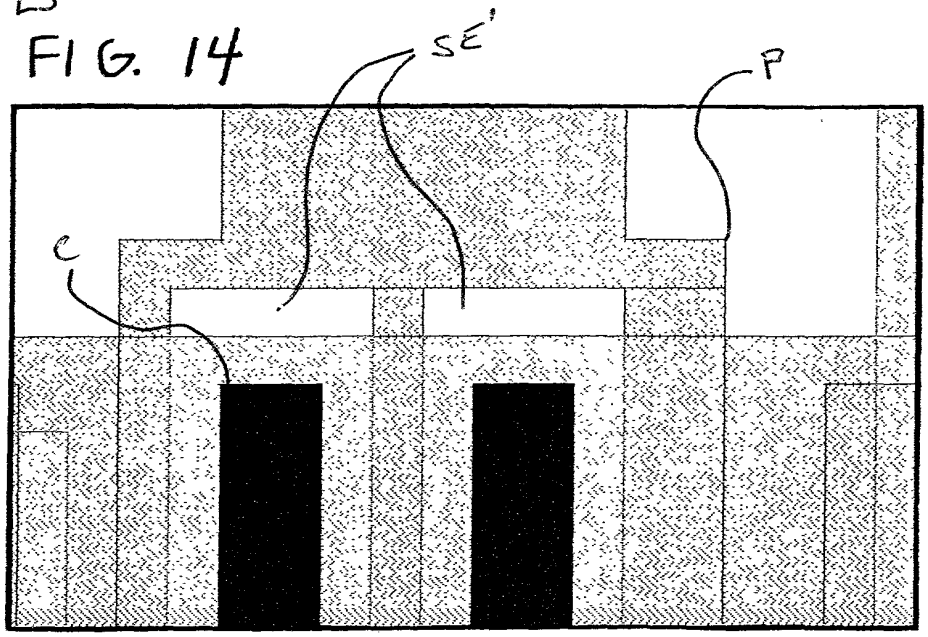
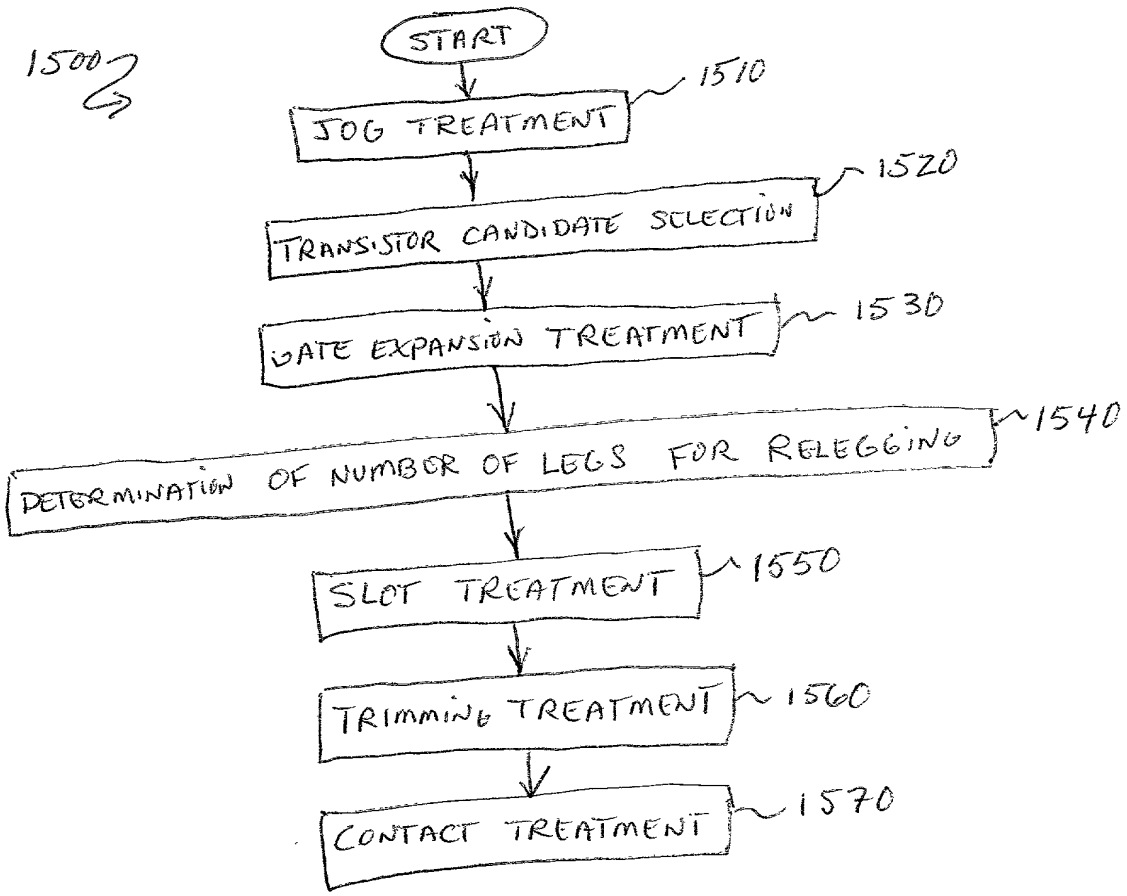
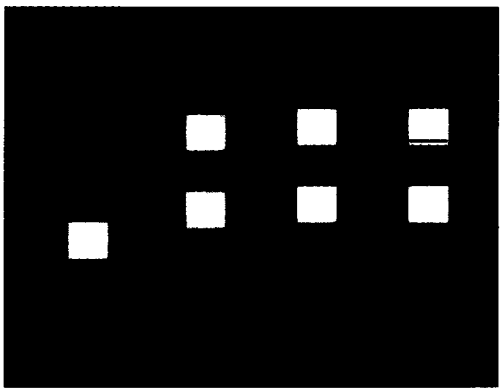


FIG. 15

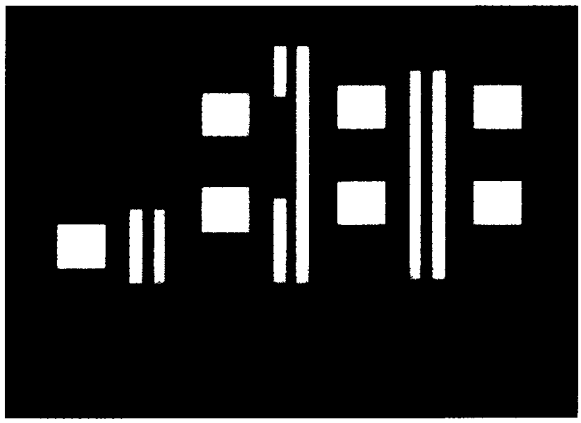

1500
START
JOG TREATMENT
1510
TRANSISTOR CANDIDATE SELECTION
1520
GATE EXPANSION TREATMENT
1530
DETERMINATION OF NUMBER OF LEGS FOR RELEGGING
1540
SLOT TREATMENT
1550
TRIMMING TREATMENT
1560
CONTACT TREATMENT
1570

COL R COPIES OF;



F16.3

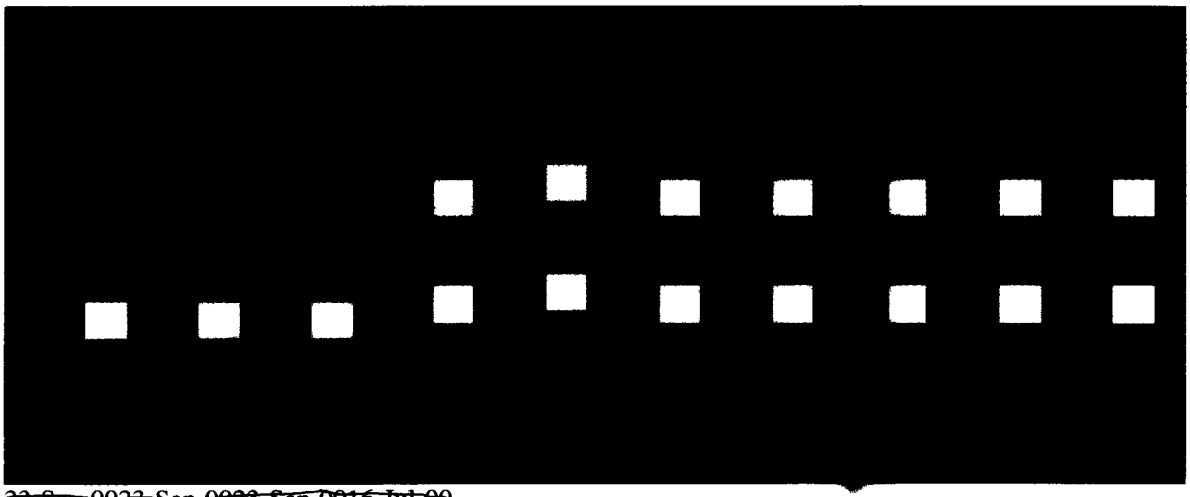
~~(b) Prepare device for re-legging~~

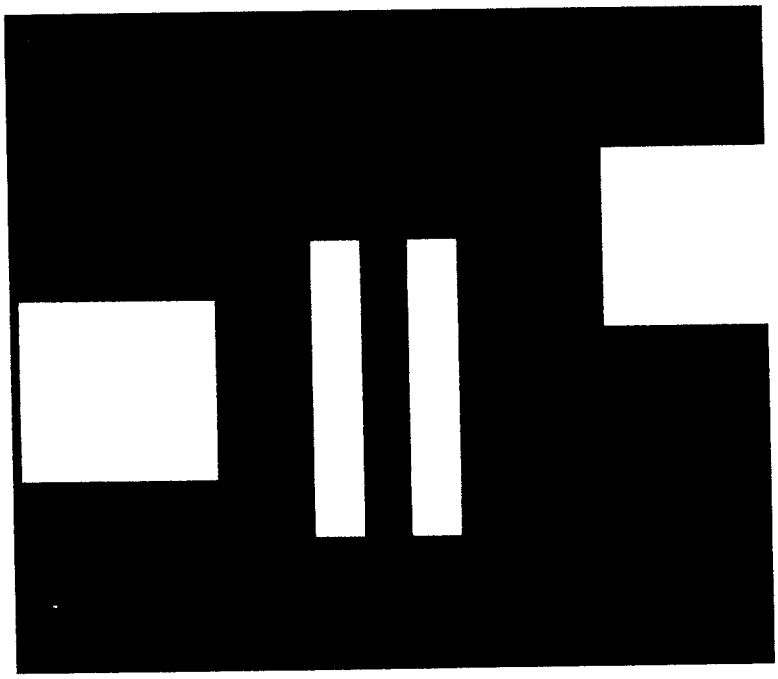


F16 4

~~(c) Re-legged device after compaction~~

F16.6





COLL: COPY OF

FIG. 5

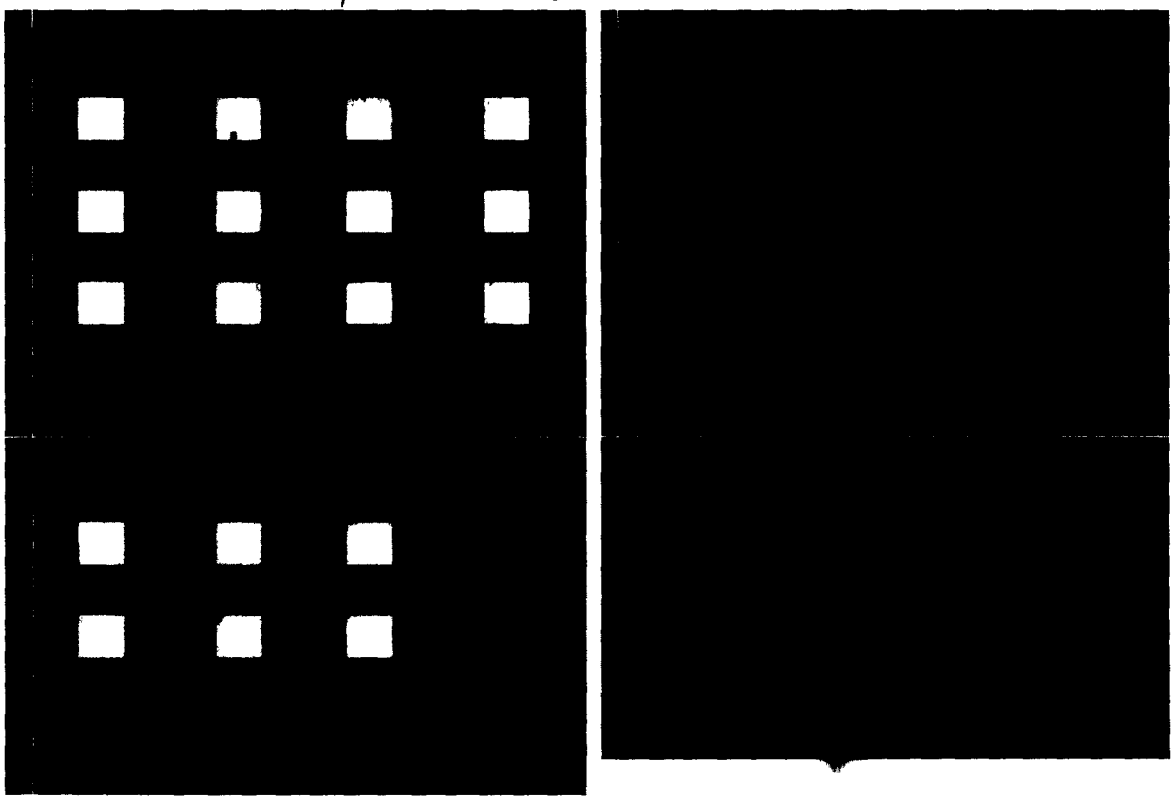
Re-legging layout flow

Re-legging is strongly connected to the performance (timing) of the layout and the target technology of migration. This means that in a re-legging flow there are external directives which point to those legs in the layout for which re-legging needs to apply. The rest of discussion contains the essential steps and techniques of re-legging

Step1: Mark all transistors in layout

Intersecting poly-silicon and diffusion does this. The resulting shapes are the active gates of the transistors in layout. Following figures depict a cell for which the transistors are marked.

COLOR COPY OF FIG. 7



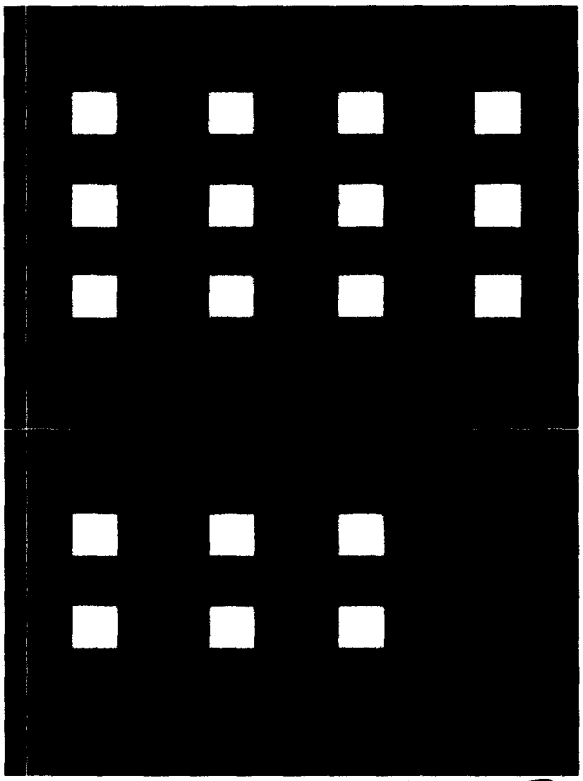
Step2: Create poly-silicon and metal1 bumps

As shown in the figures, poly and metal straps connect P and N transistors. Since re-legging requires significant exercising of the layout, the straight straps must be broken by jogs. Otherwise, the compactor that aims at stretching the layout will stack. The picture below depicts the bumps put in between the P and N devices of the cell.

COLOR COPY OF FIG. 8

Step3: Expand devices to avail enough area for later slotting of gates
Let us aiming at re-legging three out of the five devices in the underlying cell. The external directives, which are out of the scope of this document, have directed to create re-legs in the left-most P device and the two N devices.

As we see later, the creation of new re-legs involves some "surgery" in the gate area of the ones exist in the layout. Since this area may be very small, some area expansion may



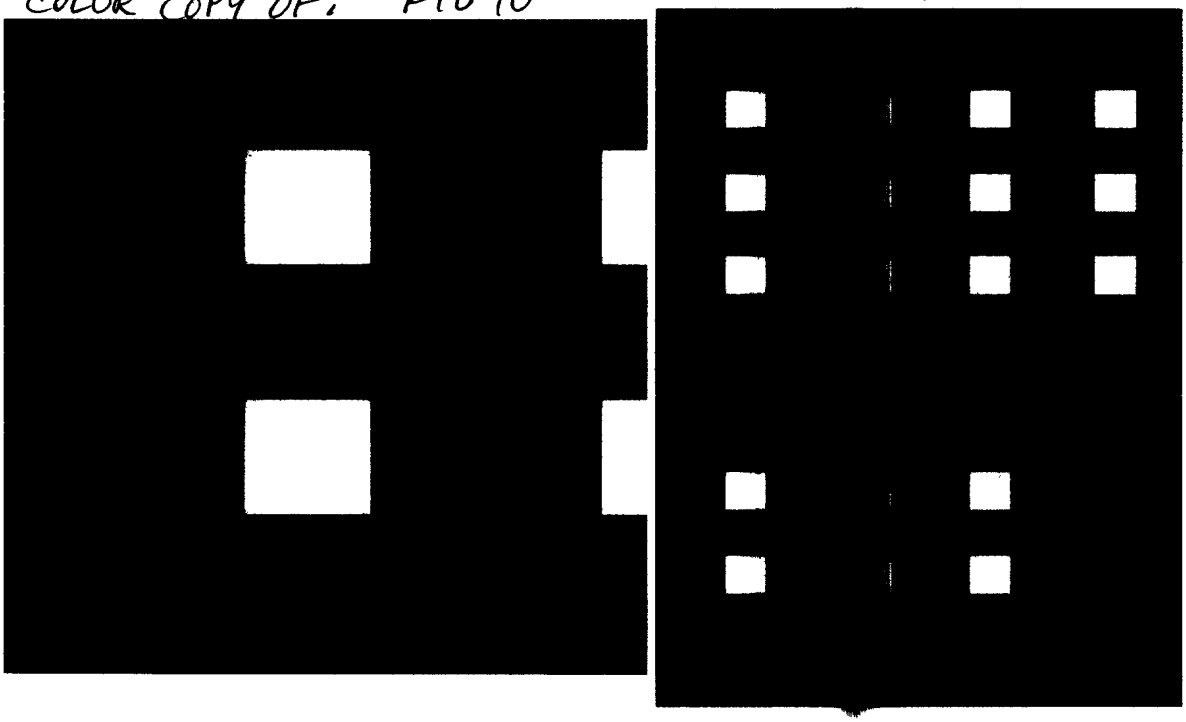
COLOR COPY OF FIG. 9

be required. This expansion is shown in the next drawing. Notice the difference in the size of the gates aimed at re-legging and those that are not.

Step4: Device slotting preparation
In order to create new legs, slots are first be inserted into the layout at the tight places. These slots are put on top of the expanded gates described above. In order to ease the re-connection of the newly created gates, re-legging maintains the evenness of the legs. Every leg, which is candidate for re-legging, defines therefore two slots, hat will later split it into three new legs.

Notice that in order to create the right topology of layout, these slots must extend beyond the area of diffusion. The drawing below depicts the slotting. A N device is magnified to better illustrate the idea.

COLOR COPY OF: FIG 10 FIG 11



Step5: Trimming poly under slots and contact preparations
Once slots are defined by the above step, once they are subtracted from the poly-silicon layer, an original normal leg is turned into three thin legs connected in parallel. Trimming poly-silicon leaves two uncovered diffusion between adjacent legs which is in the source node (and drain node) of two legs connected together.

Assume that the source node is the left uncovered. It then must be connected to the right side of the original leg. In a similar way, the right uncovered diffusion, which is now the drain node, must be connected to the left side of the original leg. In order to ease this task, seeds of contacts covered by metal pads are implanted in the uncovered diffusion area.

COLOR COPIES OF

Notice that all the above geometric manipulation, though creating right layout topology, entirely ignore any design rule. Thus, the resulting layout is illegal for manufacturing. It is the role of a compaction engine to return the layout into proper dimensions, obeying all technology rules.

FIG 12

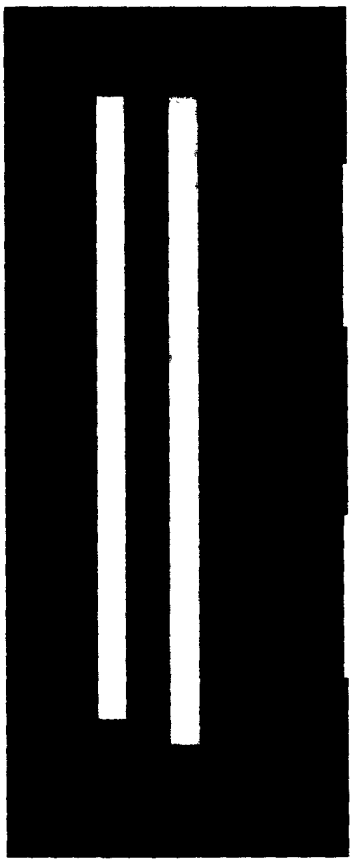


FIG. 13

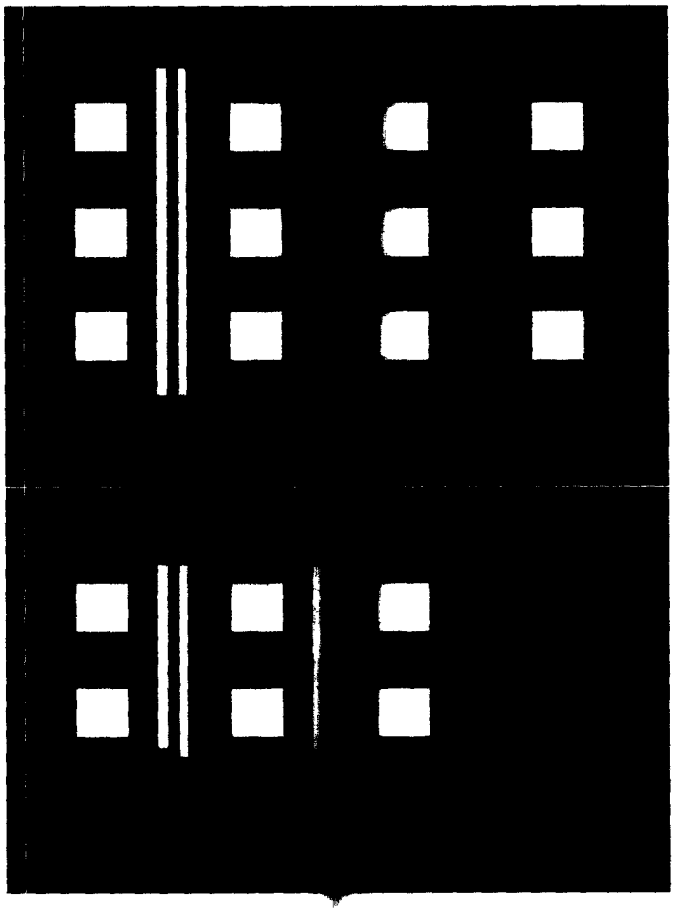


FIG. 14